DOCUMENT RESUME

ED 172 918 PS 010 669

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TITLE Effects of the Knowledge Base on Children's Rehearsal and Organizational Strategies.
PUB DATE Mar 79
NOTE 14p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (San Francisco, California, March 15-18, 1979)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Age Differences; Children; Cognitive Development; Cognitive Processes; *Knowledge Level; *Memorizing; *Memory; *Mnemonics; Psychological Studies; *Recall (Psychological); Research

ABSTRACT

In addition to the important role of memory strategies in mediating age changes in recall performance, it is clear that the permanent memory system (or information available in the knowledge base) exerts a significant influence on the acquisition and retention of information. Age changes in memory performance will be fully understood only through the investigation of the interrelationships among memory processes and the evolving knowledge base. It seems likely that the knowledge base can affect memory performance either "directly" or mediated via the operation of deliberate memory strategies. Research on verbal rehearsal and organization provides an example of the "direct" case. Given a stimulus list with a strong built-in organization (such as a set of taxonomic categories presented in a blocked fashion), children who are active and passive rehearsers show minimal differences in performance. Investigations of the mediated case concern the effects of stimulus familiarity on rehearsal and recall. Preliminary data suggest that extended familiarity with to-be-remembered materials, perhaps resulting in stronger inter-item associations in the knowledge base, may be critical for the maximally efficient execution of active rehearsal techniques. This and other findings suggest that the implementation of a deliberate organizational strategy is not content free, but rather depends upon the nature of the to-be-remembered material to which the strategy is to be applied. (Author/SS)

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Effects of the Knowledge Base on Children's Rehearsal and Organizational Strategies

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PS 010669

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A substantial research literature attests to the importance of subject-controlled processes and strategies in the memory performance of both adults and children. A somewhat smaller, but still impressively sized literature demonstrates convincingly that during the elementary school years children become increasingly proficient at a number of important mnemonic strategies for storing and retrieving information. Although we do not yet know very much about the variables that affect the development and application of these strategies, we do know that their implementation is strongly related to recall success. Thus, for example, there are substantial developmental changes in the rehearsal and organizational techniques that children employ when they are asked to memorize lists of verbal materials. These changes seem responsible for much of the recall improvement with age that is typically observed.

In addition to the important role of memory strategies in mediating age changes in recall performance, it is clear that the permanent memory system or knowledge base exerts a significant influence on the acquisition and retention of information. In this regard, there has been longstanding interest in the philosophical and psychological literatures concerning the role an individual's knowledge plays in influencing the acquisition of new information. Within experimental psychology, for example, this point of view has been most closely identified with various types of constructivist and schema theories (including those of Barlettt and Piaget, as well as more current articulations of these positions), but it also has been seen in the work of the verbal learning theorists, albeit in a rather different form. Ebbinghaus, for example, attempted

to eliminate the operation of prior knowledge about stimulus materials so that the formation of associative bonds could be examined in isolation. Later psychologists in the verbal learning tradition attempted to demonstrate the effects of prior knowledge under the rubric of variables such as the meaningfulness and familiarity of verbal elements. Thus, even though attention was not paid to the manner in which stored information influenced new learning, there was a clear acknowledgement of the important contribution of the knowledge base.

If the information available in the knowledge base can exert a significant influence on the memory performance of adult subjects, it must be of critical importance for an understanding of developmental changes in memory, since the contents and structure of children's permanent memory change markedly. Thus, in addition to a child's growing repertoire of memory strategies, corresponding changes in what is known about language and the subject matter with which he or she is dealing may facilitate the deep encoding and subsequent retention of new information. Not only does an older child have available more task appropriate strategies, but in addition, there is a more highly articulated permanent memory system through which incoming information can be interpreted, stored, and retrieved. A compelling demonstration of the possible role of changes in the knowledge base in mediating age-related changes in memory was presented by Chi (1978). She reported that children who are expert chess players actually remember more about the position of chess pieces than adults who are novice players, an outcome that contrasted with her presentation of the expected finding of adult superiority in tests involving digits.

It thus seems clear that what an individual already knows must influence

in some sense what he or she is able to subsequently process and remember. In fact, it is tempting to assume that once understood, the dramatic changes in children's knowledge about the world can account for their increasing mnemonic prowess, overshadowing the contribution of age-related changes in strategy deployment. However, it is our view that these two themes -- the operation of strategies and of the knowledge base -- are not in conflict with each other. For us, the critical issue becomes that of understanding how the age changes in the structure of the knowledge base are related to the types of memory strategies that children of different ages utilize. It seems quite likely that the information available in the knowledge base sets limits on the strategies that are employed at any time. We suggest that age changes in memory performance will only be fully understood through the investigation of the interrelationships among memory processes and the evolving knowledge base.

Although Chi (e.g., 1978) has provided important demonstrations of the effects of the knowledge base on memory performance, it must be emphasized that we currently have little insight concerning how these effects are mediated, and almost no information about age changes in the linkage between the existing state of the knowledge base and memory performance. A correlation between an individual's status (e.g., expert vs. novice) vis à vis a particular subject matter area and his or her recall of materials from this domain does not constitute an explanation of how such differences arise. We need, first of all, to know how the particular aspect of the knowledge base is structured. Second, we need to utilize procedures to identify the mnemonic processes (both deliberate and non-deliberate) that are called into operation in the use of this domain in the acquisition of new information. Finally, we need to determine how these processes change with the age-related developments in the contents

and structure of the knowledge base. In this regard, Voss and his colleagues (Chiesi, Spilich, & Voss, in press; Spilich, Vesonder, Chiesi, & Voss, in press) have begun to attack the question of knowledge base mediation with adult experts and nonexperts in one particular body of knowledge, namely baseball. Voss was able to demonstrate that strategies such as chunking, information monitoring, and selective attention can be influenced by the subjects' knowledge of the content area. Although adult performance was studied, the implications of the findings are clearly relevant for developmental analysis.

We suggest that a person's knowledge of the world can be seen to influence his or her memory performance in two different ways. In some instances, the contents and structure of the permanent memory system appear to have a quite "automatic" effect in memory tasks, in that there does not seem to be mediation by observable mnemonic strategies. In contrast, in other situations, the information available in the knowledge base affects memory via the operation of deliberate memory strategies. However, it should be pointed out that even the more "automatic" aspects of the operation of the knowledge base must reflect a series of processes that involve, for example, the identification and elaboration of the stimuli and the formation of inferences about the to-be-remembered information. We know relatively little about these automatic types of memory processes, but in contrast to deliberate mnemonic strategies which are by definition conscious, planned, and under the subject's control, they seem to be unconscious, unplanned and not subject to the capacity limitations of a short-term memory system (Naus & Halasz, 1979).

Because we have been closely identified with investigations of memory strategies, we would like to focus on demonstrations of the effects of the knowledge base on the operation of these strategies. We will utilize

research on verbal rehearsal and organization carried out in our laboratories to demonstrate how the current state of a child's permanent memory system might affect his or her utilization of certain mnemonic strategies. We will also illustrate certain seemingly direct influences of the knowledge base upon memory performance, effects that point up some boundary conditions concerning the usefulness of rehearsal strategies. And, as far as these direct effects of the knowledge base are concerned, we freely admit that at this time we have little insight into the automatic processes that might be in operation.

First let us consider the operation of verbal rehearsal in children's memory. When requested to rehearse aloud in the context of a free recall task, second and third graders tend to practice each item as it is presented, either alone, or in minimal combination with other list items. In contrast, sixth graders and older children rehearse each to-be-remembered word with a number of other words in a variety of different list contexts. Ornstein and Naus (1978) and others have shown that these differences in rehearsal patterns are related directly to developmental differences in recall, especially with relatively unrelated materials.

We have speculated that the active rehearsal patterns of older subjects are effective because of multiple inter-item associations that are created due to the extensive stimulus intermixing. Active rehearsal seems to us to involve the generation of a type of stimulus organizational structure, and if this is the case, its importance should diminish when subjects are presented with highly structured stimulus materials to remember. Given a stimulus list with a strong built-in organization (such as a set of taxonomic categories presented in a blocked fashion), subjects with knowledge of the verbal relationships in permanent memory should be able to utilize this information to structure their memorization

attempts. Under these conditions recall differences between active and passive rehearsers should be minimized. That this was indeed the case is seen in two experiments from our research program in which rehearsal and recall were examined with sets of stimulus materials differing in the obviousness of the categorical relationships present.

With all sets of materials we observed the typical age-related progression from passive to active patterns of rehearsal. However, within each category of rehearsal, it was shown that strongly organized items are associated with enhanced recall. Thus, for example, Ornstein, Naus, and Liberty's (1975, Experiment II) third graders rehearsed in a single-item fashion with related items presented randomly and with related items presented in a blocked fashion. However, recall under the blocked presentation condition was markedly superior. Similarly, Ornstein, Naus, and Miller's (1977) sixth graders rehearsed actively, but enhanced recall was observed with highly structured materials. Data such as these indicate clear limits as to the importance of active rehearsal techniques, as well as demonstrate the powerful direct influence of information available in the knowledge base in facilitating recall. Again, however, we have little information concerning how these direct effects of the knowledge base are mediated.

Additional on-going work in our laboratories is aimed at showing that the current contents of the knowledge base can directly influence children's ability to effectively use a particular rehearsal strategy. In most of our experiments we have selected stimulus words that were known to all subjects. Working from available normative data, current elementary school textbooks, and extensive pilot work, we have constructed lists of items that the youngest of our subjects in any one study would know. Our focus has always been on children's spontaneous

rehearsal, given that all subjects know the stimulus materials. However, knowledge of items in the lexicon is not an all or none affair, and it seems quite possible that older children have more in-depth understanding -- in terms of interitem associations, nuance, etc. -- than the younger subjects we have studied. The question that arises in this context is whether it is possible that older children's greater understanding of the to-be-remembered materials might affect their tendency to use active rehearsal.

To explore this issue we are studying what happens to rehearsal and recall when young children are presented with words with which they might be very familiar, and older children are asked to memorize words whose meanings they have just recently learned. Given that our typical stimulus words are present in the reading materials of our youngest subjects, we used age-of-acquisition data and reports of the contents of the earliest lexicons to select highly familiar stimuli for second and third graders. Our preliminary findings indicate that there is some small tendency for these children to rehearse more actively than usual with these lists, and for recall facilitation to result. Stronger effects, however, seem to be found with sixth graders given word lists drawn from recent social studies and scienee units. Under these lists of relatively new items, there is a greater tendency for sixth graders to rehearse in a fashion that is more passive than usual, and for recall decrement to be observed. These preliminary data suggest that extended familiarity with to-be-remembered materials, perhaps resulting in a stronger interitem associations in the knowledge base, may be critical for the maximally efficient execution of active rehearsal techniques.

Comparable effects of the knowledge base upon mnemonic strategies can also be demonstrated through an investigation of the development of active organiza-

tional techniques. For example, Corsale and Ornstein (1977) presented third and seventh graders with several trials of a sorting task with relatively unrelated materials prior to a test of recall. Subjects were asked either to form groups that would help them to remember the items or to sort on the basis of meaning. Seventh graders sorted identically under these remember instructions and sort-for-meaning instructions, but, as expected, the third graders did not. In fact, third graders asked to group items in preparation for recall sorted in a seemingly random fashion, but those who were asked to group on the basis of meaning sorted on an organizational basis similar to the seventh graders. The recall data indicated that recall performance was always a function of the actual sorting pattern, regardless of intent to remember. Thus, third graders instructed to form meaningful groups remembered more on an incidental test of memory than those asked to sort in preparation for recall.

On the basis of these findings, it would seem that the third graders studied by Corsale and Ornstein (1977) had difficulties in responding in a strategic fashion when presented with instructions to remember, but that they did have the semantic knowledge in permanent memory to group items in a highly organized fashion. The implication that one would draw is that these children do not apply their knowledge strategically in the context of a recall situation, and this outcome might be characterized as a production deficiency. However, as was demonstrated with children's rehearsal strategies, there may be gradations in the use of organizational techniques. Even young children might utilize active organizational strategies when presented with certain types of highly salient stimulus materials. Confirmation of this viewpoint is seen in Corsale's (1978) recent demonstration that when presented with taxonomic stimulus materials in a sort/recall task, third graders sorted spontaneously in a categorically

based fashion, even under instructions to remember. The implication of these findings would be to suggest that the implementation of a deliberate organizational strategy is not content free, but rather depends upon the to-be-remembered materials to which the strategy is to be applied. When presented with unstructured materials, third graders performed in a seemingly astrategic fashion, but they invoked sophisticated organizational strategies when given categorically organized materials.

To sum up this treatment of knowledge base effects, it seems clear to us that it is important to examine age changes in the deployment of deliberate memorization techniques in the context of the child's permanent memory system. The child's utilization of strategies in response to a memorization situation does not just depend upon the availability of these techniques in the repertorie and upon his or her metamemory judgment concerning the usefulness of these skills for remembering. As we have tried to point out, the implememtation of certain strategies seems also to depend upon the characteristics of the stimulus materials to which the strategies are applied. If we are to understand the development of the memory system, it is necessary to explore systematically the emergence of children's attempts at skilled remembering in the context of important changes in the contents and structure of the permanent memory system.

In addition, it is also necessary to supplement these studies of the linkage between the knowledge base and deliberate memory strategies with parallel investigations of the relationship between the current status of the knowledge base and the use of more automatic mnemonic processes. Although there is little empirical work which directly investigates the development of automatic processes,

it seems apparent that the use of processes such as the making of inferences is directly determined by the content and structure of the relevant information already in permanent memory (see Naus & Halasz, 1979). We need to examine the operation of these processes because they are important for a full account of the direct influence of the knowledge base upon memory performance. An additional reason for such studies stems from Lange's (1978) observation that in some situations what appear to be deliberate memory strategies such as category clustering in free recall may turn out to be the more or less automatic result of strong interitem associations in the knowledge base.

One final set of considerations must be mentioned. Implicit in our discussion of the linkage between the knowledge base and memory strategies and processes is the need to be able to precisely define the current status of permanent memory, at least with reference to selected domains, and to explore simultaneously variations in knowledge and in the use of strategies and processes. The work described here is only preliminary to a more thorough series of such studies. We are moving in this direction, however, because we are currently seeking to observe differences in the rehearsal and organizational skills of experts and nonexperts in particular skill areas who are placed in memorization tasks involving information from these domains. And, perhaps more importantly, to break away from the problem that in most situations age, strategy usage, and degree of knowledge are perfectly correlated, we are attempting to explore these issues with new bodies of knowledge that are being taught to individuals of different ages. An examination of the operation of both automatic processes and deliberate strategies used by children of different ages who have varying levels of sophistication with particular subject matter domains should prove to be most informative. We hope to be able to report these findings at the next SRCD meeting.

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